# Land Information System (LIS) Requirements Document

Submitted under Task Agreement GSFC-CT-2

Cooperative Agreement Notice (CAN)
CAN-00OES-01

Increasing Interoperability and Performance of Grand Challenge Applications in the Earth, Space, Life, and Microgravity Sciences

March 14, 2003

Revision 2.0

History:

| Revision | Summary of Changes | Date |
|---|---|---|
| 2.0 | Milestone H Updates | March 14, 2003 |
| 1.0 | Initial Version (Milestone E) | July 2002 |

# 1 Introduction

The purpose of this document is to describe the requirements of the Land Information System (LIS) to be implemented under funding from NASA's Computational Technologies (formerly High Performance Computing and Communications) Project. The requirements given herein are derived from several sources, including 1) the original LIS proposal; 2) the LIS grand-kickoff meeting, held March 4, 2002; 3) a formal requirements gathering process conducted by members of the GSFC LIS team, and 4) input from others, including the full Land Data Assimilation System (LDAS) and LIS teams.

The requirements are organized along the following topical areas:

- LIS General Requirements
- LIS Science Requirements
- Performance Requirements
- Usage Requirements
- Platforms
- Data Management
- Data Reliability and Security
- Online Documentation

Each requirement in this document has been assigned a priority number. A value of 1 designates the highest priority level, and so on.

Each requirement refers to a milestone. These milestones refer to the milestones documented in Task Agreement GSFC-CT-2 under Cooperative Agreement Notice CAN-00-OES-01 Increasing Interoperability and Performance of Grand Challenge Applications in the Earth, Space, Life, and Microgravity Sciences.

# 2 Descriptions

## 2.1 LIS

The Land Information System (LIS) will have the following components: (1) A high-resolution (1km) Land Data Assimilation System (LDAS), involving several independent community Land Surface Models (LSMs), land surface data assimilation technologies, and integrated database operations for observation and prediction data management; and (2) A web-based user interface based on the GRid Analysis and Display System (GrADS) and the Distributed Oceanographic Data System (DODS) for accessing data mining, numerical modeling, and visualization tools. The LIS will be available as a "production" system on a centralized server for large applications. By incorporating and promulgating the existing Assistance for Land_surface Modeling Activities (ALMA; http://www.lmd.jussieu.fr/ALMA/ ) and DODS standards for model coupling and data visualization, LIS will contribute to the definition of the land surface modeling and assimilation standards for the Earth System Modeling Framework (ESMF).

## 2.2 Land Surface Modeling and Data Assimilation

In general, land surface modeling seeks to predict the terrestrial water, energy and biogeochemical processes by solving the governing equations of the soil-vegetation-snowpack medium. Land surface data assimilation seeks to synthesize data and land surface models to improve our ability to predict and understand these processes. The ability to predict terrestrial water, energy and biogeochemical processes is critical for applications in weather and climate prediction, agricultural forecasting, water resources management, hazard mitigation and mobility assessment.

In order to predict water, energy and biogeochemical processes using (typically 1-D vertical) partial differential equations, land surface models require three types of inputs: 1) initial conditions, which describe the initial state of land surface; 2) boundary conditions, which describe both the upper (atmospheric) fluxes or states also known as "forcings" and the lower (soil) fluxes or states; and 3) parameters, which are a function of soil, vegetation, topography, etc., and are used to solve the governing equations.

## 2.3 Land Data Assimilation System (LDAS)

LDAS is a model control and input/output system (consisting of a number of subroutines, modules written in Fortran 90 source code) that drives multiple offline one dimensional land surface models (LSMs) using a vegetation defined "tile" or "patch" approach to simulate sub-grid scale variability. The one-dimensional LSMs such as CLM and NOAH, which are subroutines of LDAS, apply the governing equations of the physical processes of the soil-vegetation-snowpack medium. These land surface models aim to characterize the transfer of mass, energy, and momentum between a vegetated surface and the atmosphere.

LDAS makes use of various satellite and ground based observation systems within a land data assimilation framework to produce optimal output fields of land surface states and fluxes. The LSM predictions are greatly improved through the use of a data assimilation environment such as the one provided by LDAS. In addition to being forced with real time output from numerical prediction models and satellite and radar precipitation measurements, LDAS derives model parameters from existing topography, vegetation and soil coverages. The model results are aggregated to various temporal and spatial scales, e.g., 3 hourly, 1/4°.

The execution of LDAS starts with reading in the user specifications. The user selects the model domain and spatial resolution, the duration and timestep of the run, the land surface model, the type of forcing from a list of model and observation based data sources, the number of "tiles" per grid square (described below), the soil parameterization scheme, reading and writing of restart files, output specifications, and the functioning of several other enhancements including elevation correction and data assimilation.

The system then reads the vegetation information and assigns subgrid tiles on which to run the one-dimensional simulations. LDAS runs its 1-D land models on vegetation-based "tiles" to simulate variability below the scale of the model grid squares. A tile is not tied to a specific location within the grid square. Each tile represents the area covered by a given vegetation type.

Memory is dynamically allocated to the global variables, many of which exist within Fortran 90 modules. The model parameters are read and computed next. The time loop begins and forcing data is read, time/space interpolation is computed and modified as necessary. Forcing data is used to specify boundary conditions to the land surface model. The LSMs in LDAS are driven by atmospheric forcing data such as precipitation, radiation, wind speed, temperature, humidity, etc., from various sources. LDAS applies spatial interpolation to convert forcing data to the appropriate resolution required by the model. Since the forcing data is read in at certain regular intervals, LDAS also temporally interpolates time average or instantaneous data to that needed by the model at the current timestep. The selected model is run for a vector of "tiles", intermediate information is stored in modular arrays, and output and restart files are written at the specified output interval.

## 2.4 Community Land Model (CLM)

CLM is a 1-D land surface model, written in Fortran 90, developed by a grassroots collaboration of scientists who have an interest in making a general land model available for public use. LDAS currently uses CLM version 1.0, formerly known as common land model. CLM version 2.0 was released in May 2002 and will be implemented in LDAS in future. The source code for CLM 2.0 is freely available from the National Center for Atmospheric Research (NCAR) (`http://www.cgd.ucar.edu/tss/clm/`). The CLM is used as the land model for the community climate system model (CCSM) (`http://www.ccsm.ucar.edu/`) and the community atmosphere model (CAM) (`http://www.cgd.ucar.edu/cms/`). CLM is executed with all forcing, parameters, dimensioning, output routines, and coupling performed by an external driver of the user's design (in this case done by LDAS). CLM requires pre-processed data such as the land surface type, soil and vegetation parameters, model initialization, and atmospheric boundary conditions as input. The model applies finite-difference spatial discretization methods and a fully implicit time-integration scheme to numerically integrate the governing equations. The model subroutines apply the governing equations of the physical processes of the soil-vegetation-snowpack medium, including the surface energy balance equation, Richards' [4] equation for soil hydraulics, the diffusion equation for soil heat transfer, the energy-mass balance equation for the snowpack, and the Collatz et al. [2] formulation for the conductance of canopy transpiration.

## 2.5 The Community NOAH Land Surface Model

The community NOAH Land Surface Model is a stand-alone, uncoupled, 1-D column model freely available at the National Centers for Environmental Prediction (NCEP; `ftp://ftp.ncep.noaa.gov/pub/gcp/ldas/noahlsm/`). NOAH can be executed in either coupled or uncoupled mode. It has been coupled with the operational NCEP mesoscale Eta model [1] and its companion Eta Data Assimilation System (EDAS) [5], and the NCEP global Medium-Range Forecast model (MRF) and its companion Global Data Assimilation System (GDAS). When NOAH is executed in uncoupled mode, near-surface atmospheric forcing data (e.g., precipitation, radiation, wind speed, temperature, humidity) is required as input. NOAH simulates soil moisture (both liquid and frozen), soil temperature, skin temperature, snowpack depth, snowpack water equivalent, canopy water content, and the energy flux and water flux terms of the surface energy balance and surface water balance. The model applies finite-difference spatial discretization methods and a Crank-Nicholson time-integration scheme to numerically integrate the governing equations of the physical processes of the soil vegetation-snowpack medium, including the surface energy balance equation, Richards' [4] equation for soil hydraulics, the diffusion equation for soil heat transfer, the energy-mass balance equation for the snowpack, and the Jarvis [3] equation for the conductance of canopy transpiration.

## 2.6 Variable Infiltration Capacity Model

Variable Infiltration Capacity (VIC) model is a macroscale hydrologic model, written in C, being developed at the University of Washington, and Princeton University. The VIC code repository along with the model description and source code documentation is available `http://www.hydro.washington.edu/Lettenmaier/Models/VIC/VIChome.html`. VIC is used in macroscopic land use models such as SEA - BASINS (`http://boto.ocean.washington.edu/seasia/intro.htm`). VIC is a semi-distributed, grid-based hydrological model, which parameterizes the dominant hydrometeorological processes taking place at the land surface - atmospheric interface. The execution of VIC model requires preprocessed data such as precipitation, temperature, meteorological forcing, soil and vegetation parameters, etc. as input. The model uses three soil layers and one vegetation layer with energy and moisture fluxes exchanged between the layers. The VIC model represents surface and subsurface hydrologic processes on a spatially distributed (grid cell) basis. Partitioning grid cell areas to

different vegetation classes can approximate sub-grid scale variation in vegetation characteristics. VIC models the processes governing the flux and storage of water and heat in each cell-sized system of vegetation and soil structure. The water balance portion of VIC is based on three concepts:
1) Division of grid-cell into fraction sub-grid vegetation coverage.
2) The variable infiltration curve for rainfall/runoff partitioning at the land surface.
3) A baseflow/deep soil moisture curve for lateral baseflow.

Water balance calculations are preformed at three soil layers and within a vegetation canopy. An energy balance is calculated at the land surface. A full description of algorithms in VIC can be found in the references listed at the VIC website.

# 3 LIS General Requirements

3.1 GrADS-DODS for Data Management

Statement: LIS shall use a GrADS-DODS system for data management.

Source: LIS Milestones

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

3.2 LDAS for Data Assimilation

Statement: LIS shall use LDAS for data assimilation.

Source: LIS Milestones

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

3.3 CLM in LIS

Statement: The Community Land Model (CLM) shall run in LIS.

Source: LIS Milestones

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

### 3.4 NOAH in LIS

Statement: The NOAH Land Model shall run in LIS.

Source: LIS Milestones

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

### 3.5 VIC in LIS

Statement: The Variable Infiltration Capacity (VIC) Land Model shall run in LIS.

Source: LIS Milestones

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

### 3.6 ALMA for Input Variables

Statement: The Assistance for Land-surface Modeling Activities (ALMA) standard shall be used for input variables.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

### 3.7 ALMA for Output Variables

Statement: The ALMA standard shall be used for output variables.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

### 3.8 ESMF Compliance

Statement: LIS shall comply with ESMF standards.

Source: Proposal

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

3.9 Internet-enabled User Interface

Statement: LIS shall provide a secured internet-enabled user interface.

Source: LIS Milestones, NPG 2810

Priority: 3

Milestone: K (Aug 2004)

Dependencies: Reqs. 6.1, 6.2

Notes:

# 4 LIS Science Requirements

4.1 Land Surface Modeling

Statement: LIS shall support global, regional or local land surface modeling.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies: Reqs. 8.2, 8.3.2, 8.3.3, 8.3.4

Notes:

4.2 Water and Energy Balance

Statement: LIS shall support water and energy balance modeling of the land surface.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

4.2.1 Computation at User-defined Time Intervals

Statement: LIS shall support computation, input and output of water and energy fluxes and state variables at user-defined time intervals during a simulation.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

#### 4.2.2 Mass and Energy Conservation

Statement: LIS' regridding routines shall ensure mass and energy conservation.

Source: Internal (Paul Houser)

Priority: 3

Milestone: K (Aug 2004)

Dependencies: ESMF

Notes:

### 4.3 Land/Water Mask

Statement: LIS shall support the definition of the land surface domain by a land/water mask to eliminate ocean points from a given grid.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

### 4.4 Run-time Definition of Domain

Statement: LIS shall allow for the definition of the model application domain at run-time.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

#### 4.4.1 Domain Definition

Statement: The model application domain definition shall include

- spatial resolution: 2x2.5 deg., 1/4 deg., 5km, 1km
- map projection: lat/lon, Goode Homolosine, Lambert-Conformal
- geoid: TBD
- horizontal extent: 60S–90N deg lat., 0–360 deg lon., maximum
- vertical layers: 10 soil, 5 snow for CLM; 4 layers for NOAH
- number of tiles or tile quantile (aka cutoff):
  - 1–M tiles per grid-cell at 1/4 deg. resolution
  - 1–N tiles per grid-cell at 5km resolution

– 1 tile per grid-cell at 1km resolution

Source: Proposal, Internal (Paul Houser)

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

4.4.2 Dynamic Tile Use

Statement: LIS shall support dynamic definition of tiles during a given simulation.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

4.4.3 Tile Definition

Statement: LIS shall support a general definition of "tiles" or subgrid patches based on a combination of dynamic and static properties, including vegetation, soils, topography, forcing, or other data as needed.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

4.4.4 Time-stepping

Statement: LIS shall be able to run at 900 and 1800 second timesteps.

Source: Internal (Paul Houser)

Priority: 2

Milestone: G (Feb 2004)

Dependencies: Req. 8.3.5

Notes:

4.4.5 I/O of Gridded and Point Data

Statement: LIS shall support the input and output of 1-d, 2-d and 3-d gridded (raster) data as well as point data.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies: Req. 8.2

Notes:

4.4.6 Support for Time-dependent Variables

Statement: LIS shall support variables that change in time and 3-d space.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

4.4.7 Restart Support

Statement: LIS shall allow a “restarted” simulation to run over a redefined grid.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies: Reqs. 4.1, 6.4, 6.5, 8.3.1

Notes:

4.4.8 Start-time and End-time

Statement: LIS shall allow for the definition of the model starting date and time and the ending date and time at runtime.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies: Req. 8.3.5

Notes:

4.4.9 Mandatory Output

Statement: LIS shall output all variables marked as “mandatory” by the ALMA standard.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

4.4.10 Output Frequency

Statement: LIS shall have a fixed output frequency during a given simulation.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

4.4.11 6-d Gridded Output

Statement: LIS shall support 6-d (t,x,y,z,tile,LSM) gridded output.

Source: Internal (Christa Peters-Lidard)

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

4.4.12 Quality Control Output

Statement: LIS shall have the capability to output the gridded/interpolated input data for quality control/analysis purposes.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

# 5 Performance Requirements

5.1 1 ms per grid cell per day Throughput

Statement: LDAS with CLM and NOAH shall have a throughput of 1 ms per grid cell per day of execution on the SGI Origin 3000 for a near-term retrospective period computed at a 5 km resolution.

Source: LIS Milestones

Priority: 1

Milestone: F (Mar 2003)

Dependencies: Req. 7.3

Notes:

5.2 0.4 ms per grid cell per day Throughput

Statement: LIS shall have a throughput of approximately 0.4 ms per grid cell per day of execution on the LIS Linux cluster for a near-term retrospective period computed at a 1 km resolution.

Source: LIS Milestones

Priority: 2

Milestone: G (Feb 2004)

Dependencies: Req. 7.6

Notes:

5.3 Performance Monitoring

Statement: LIS Linux cluster shall have tools for monitoring and measuring throughput and node utilization.

Source: LIS Milestones

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

# 6 Usage Requirements

6.1 User Levels

Statement: LIS shall have three different user-levels – general public, registered researcher, and developer.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

6.2 Web Browser User Interface

Statement: LIS shall have a secured internet-enabled user interface accessible via world wide web browsers.

Source: LIS Milestones, NPG 2810

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

6.2.1 Read-only Access for General Public

Statement: The LIS user interface shall provide the general public read-only access to processed data.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

#### 6.2.1.1 Animated or Still Output Images

Statement: The LIS user interface shall provide output images in animation or still format.
Source: LIS Milestones
Priority: 2
Milestone: G (Feb 2004)
Dependencies:
Notes:

#### 6.2.1.2 Contour or Shaded Output Images

Statement: The LIS user interface shall provide output images in contour or shaded plot format.
Source: LIS Milestones
Priority: 2
Milestone: G (Feb 2004)
Dependencies:
Notes:

### 6.2.2 Password-restricted Access to Data

Statement: The LIS user interface shall provide password-restricted access to data via FTP or Grads-DODS Server for registered researchers and developers.

Source: Internal (Luther Lighty), NPG 2810

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

#### 6.2.2.1 Near-real-time Access to Data

Statement: The LIS user interface shall provide access to data on the LIS GrADS-DODS server in near-real-time.
Source: Internal (Yudong Tian)
Priority: 3
Milestone: K (Aug 2004)
Dependencies:
Notes:

### 6.2.3 Password-restricted Access to Run Land Surface Models

Statement: The LIS user interface shall provide password-restricted access to perform Land Surface Modeling for registered researchers and developers.

Source: Internal (Luther Lighty), NPG 2810

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

6.3 Configuration

Statement: LIS user interface shall support the configuration of LDAS and LSMs via a web browser.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies: Req. 6.2

Notes: A standard configuration for each LSM will be supplied.

6.4 Initialization via Restart

Statement: LIS shall allow for the initialization of state variables using data or saved states from a previous run.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

6.5 Write Restart Data

Statement: LIS shall provide output of state variables for use in future initializations.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

6.6 Queuing System

Statement: LIS shall provide a queuing system on the LIS Linux cluster to monitor the demand requests.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

6.7 Batch Mode for Operation

Statement: LIS shall execute normal job requests in batch mode where input data, configuration, and output data are read and stored directly from file.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

6.8 Debug Mode

Statement: LIS shall support a debug mode where developers may run special test runs of LIS.

Source: Internal (Yudong Tian)

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

6.9 Error Logging

Statement: LIS shall log all LIS system errors. LIS system error logs and error logs generated by LDAS and the NOAH, CLM, and VIC LSMs shall be available to registered researchers and developers.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

6.10 Publicly Released Documentation and Source Code

Statement: The LIS web interface shall provide publicly released software documentation and source code.

Source: Internal (Luther Lighty)

Priority: 1

Milestone: F (Mar 2003)

Dependencies:

Notes:

# 7 Platforms

7.1 LIS Shall Run on LIS Cluster

Statement: LIS shall run on the LIS Linux cluster.

Source: LIS Milestones

Priority: 2

Milestone: G (Feb 2004)

Dependencies: Reqs. 6.2.1.1, 6.2.1.2, 6.8, 7.6, 8.2, 8.3, 8.4

Notes:

7.2 NOAH and CLM at 1/4 deg on SGI Origin 3000

Statement: LDAS and the NOAH and CLM LSMs shall run on the SGI Origin 3000 at 1/4 deg resolution.

Source: LIS Milestones

Priority: 1

Milestone: E (Jul 2002)

Dependencies:

Notes: This provides a test of the portability of the LSMs.

7.3 NOAH and CLM at 5 km on SGI Origin 3000

Statement: LDAS and the NOAH and CLM LSMs shall run on the SGI Origin 3000 at 5 km resolution.

Source: LIS Milestones

Priority: 1

Milestone: F (Mar 2003)

Dependencies:

Notes: This provides a test of the portability of the LSMs.

7.4 VIC at 5 km on SGI Origin 3000

Statement: LDAS and the VIC LSM shall run on the SGI Origin 3000 at 5 km resolution.

Source: LIS Milestones

Priority: 1

Milestone: I (Jul 2003)

Dependencies:

Notes: This provides a test of the portability of the LSM.

7.5 LDAS and LSMs at 5 km on LIS Linux cluster

Statement: LDAS and the NOAH, CLM, and VIC LSMs shall run on the LIS Linux cluster at 5 km resolution.

Source: LIS Milestones

Priority: 1

Milestone: I (Jul 2003)

Dependencies:

Notes:

7.6 LDAS and LSMs at 1 km on LIS Linux cluster

Statement: LDAS and the NOAH, CLM, and VIC LSMs shall run on the LIS Linux cluster at 1 km resolution.

Source: LIS Milestones

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

7.7 GUI Web Browser for User Interface

Statement: LIS client user interface shall be supported on systems with a GUI web browser.

Source:

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

# 8 Data Management

8.1 Data Management Shall Support LIS

Statement: The management of LIS input/output data shall support the near-real-time operation of LIS.

Source: Proposal

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

### 8.2 I/O in GrADS-DODS Format

Statement: LIS shall support I/O in any GrADS-DODS supported format.

Source: Proposal

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

### 8.3 Input Data

Statement: LIS input data shall consist of

- GEOS forcing data
- NRL precipitation data
- AGRMET short wave radiation data
- AGRMET long wave radiation data

Source: LDAS

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

#### 8.3.1 Input Data Sources

Statement: LIS shall be able to get input data from the following sources:

- GrADS-DODS servers via DODS protocol
- ALMA compliant providers with standard ALMA protocol
- Traditional data sources with direct, automatic fetch via FTP or HTTP.
- LIS-generated restart files.

Source: Internal (Yudong Tian)

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

#### 8.3.2 Re-mapping of Input Data

Statement: LIS shall be able to re-map input data between grids, points and tiles.

Source: LDAS

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

#### 8.3.3 Re-projecting of Input Data

Statement: LIS shall be able to re-project input data between lat/lon, Goode Homolosine, and Lambert-Conformal projections.

Source: LDAS

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes: We expect lat/lon and Lambert-Conformal re-projections to be available via the ESMF libraries. Should Goode Homolosine re-projections be not available via the ESMF libraries, its functionality will be reevaluated.

#### 8.3.4 Input Data Spatial Interpolation

Statement: LIS shall be able to spatially interpolate gridded or point-wise input data as needed via the ipolates library or ESMF interpolation libraries to the LIS grid.

Source: LDAS

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

#### 8.3.5 Input Data Temporal Interpolation

Statement: LIS shall be able to temporally interpolate gridded or point-wise input data as needed via the LDAS zterp routine or ESMF interpolation libraries to LIS time.

Source: LDAS

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

### 8.4 Output data

#### 8.4.1 GRIB for Output Data Format

Statement: The primary format of LIS output data storage is GRIB, with accompanying metadata files.

Source: LDAS

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

8.4.2 Output Data Conversion

Statement: LIS shall be able to convert output data to binary, HDF or netCDF format.

Source: GrADS-DODS Server

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

8.4.3 Goode Homolosine for Output Data Projection

Statement: The primary projection of output data is Goode Homolosine.

Source: Internal (Paul Houser)

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

8.4.4 Re-projection of Output Data

Statement: The output data shall be able to be re-projected to lat/lon or Lambert-Conformal.

Source: Internal (Paul Houser)

Priority: 2

Milestone: G (Feb 2004)

Dependencies: ESMF

Notes: See notes for Req. 8.3.3

8.5 Data Catalog

Statement: All LIS data shall be cataloged/indexed.

Source: GrADS-DODS Server

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

8.6 Automatic Update to Catalog

Statement: The data catalogs and indexes shall be automatically updated.

Source: Internal (Yudong Tian)

Priority: 2

Milestone: G (Feb 2004)

Dependencies:

Notes:

8.7 Backup of Data

Statement: LIS data shall be backed up weekly.

Source: Internal (Yudong Tian)

Priority: 1

Milestone: K (Aug 2004)

Dependencies:

Notes:

8.8 Data Storage

Statement: LIS data shall be stored on disks with tape archives.

Source: Internal (Yudong Tian)

Priority: 1

Milestone: K (Aug 2004)

Dependencies:

Notes:

# 9 Data Reliability and Security

9.1 Data Reliability

Statement: Data shall be stored in a redundant manner to ensure data reliability.

Source: Internal (Yudong Tian)

Priority: 1

Milestone: K (Aug 2004)

Dependencies:

Notes:

9.2 Authentication and Authorization Enforcement

Statement: Authentication and authorization shall be enforced for users to have different levels of access to the data.

Source: Internal (Luther Lighty), NPG 2810

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

9.3 Web Access Monitoring

Statement: All access through the web server will be logged.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

9.4 Ftp Monitoring

Statement: All ftp activity will be logged.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

9.5 Usage Limited

Statement: Resource usage by Internet users shall be limited.

Source: Internal (Yudong Tian)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes: These resources consist of disk storage, job run-time, and length of inactive connections.

# 10 Online User Documentation

10.1 On-line Overview and Help

Statement: The LIS web interface shall provide users with an on-line overview and help functions.

Source: Internal (Luther Lighty)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes: These help functions will be geared toward the registered researcher and developer users.

10.2 FAQ

Statement: The LIS web interface shall provide users with a FAQ list.

Source: Internal (Luther Lighty)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

10.3 Highlights Page

Statement: The LIS web interface shall provide a "highlights" page showing examples of LIS applications.

Source: Internal (Luther Lighty)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

10.4 On-line Tutorial

Statement: The LIS web interface shall provide an online tutorial to learn system.

Source: Internal (Luther Lighty)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes: This tutorial will be geared toward the registered researcher and developer users.

10.5 User's Guide

Statement: The LIS user interface shall provide a link to the LIS User's Guide.

Source: Internal (Luther Lighty)

Priority: 3

Milestone: K (Aug 2004)

Dependencies:

Notes:

# References

[1] F. Chen, K. Mitchell, J. Schaake, Y. Xue, H. Pan, V. Koren, Y. Duan, M. Ek, and A. Betts. Modeling of land-surface evaporation by four schemes and comparison with fife observations. *J. Geophys. Res.*, 101(D3):7251–7268, 1996.

[2] G. J. Collatz, C. Grivet, J. T. Ball, and J. A. Berry. Physiological and environmental regulation of stomatal conducatance: Photosynthesis and transpiration: A model that includes a laminar boundary layer. *Agric. For. Meteorol.*, 5:107–136, 1991.

[3] P. G. Jarvis. The interpretation of leaf water potential and stomatal conductance found in canopies of the field. *Phil. Trans. R. Soc.*, B(273):593–610, 1976.

[4] L. A. Richards. Capillary conduction of liquids in porous media. *Physics*, 1:318–333, 1931.

[5] E. Rogers, T. L. Black, D. G. Deaven, G. J. DiMego, Q. Zhao, M. Baldwin, N. W. Junker, and Y. Lin. Changes to the operational "early" eta analysis/forecast system at the national centers of environmental prediction. *Wea. Forecasting*, 11:391–413, 1996.